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MBA PROFESSIONAL REPORT

An Analysis of the Naval Innovation Laboratory's Virtual Work Environment-Based Management Information System for Application in Joint Service Explosive Ordnance Disposal Notional Concepts Management

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By: Stephen G. Keene

December 2009

Advisors: **Michael Boudreau**
Douglas Brinkley

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The Joint Service Explosive Ordnance Disposal (JSEOD) community uses the Notional Concepts process to assess the potential for existing or emerging technologies to satisfy EOD mission needs. Notional Concepts are user-defined requirements whose ultimate aim is to produce an EOD tool or equipment item. The Notional Concepts process was created to facilitate development of new requirements, information flow, management decisions, and transition of funding from investigative research to sustained programs of record. Currently, there is no single site for the JSEOD community to receive, process, and manage Notional Concepts. The Naval Innovation Laboratory (NaIL) has a virtual work environment-based management information system for managing the U.S. Marine Corp's Urgent Universal Need Statements (UUNS,) a program similar to the JSEOD's Notional Concept program. The purpose of this report is to analyze the NaIL's Management Information System to determine if there are aspects of it that the JSEOD community could use to better manage the life cycle of their Notional Concepts.

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Stephen G. Keene, Lieutenant Commander, United States Navy

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Authors: _____
Stephen G. Keene

Approved by: _____
Michael Boudreau, Lead Advisor

_____
Douglas Brinkley, Support Advisor

_____
William R. Gates, Dean
Graduate School of Business and Public Policy

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ABSTRACT

The Joint Service Explosive Ordnance Disposal (JSEOD) community uses the Notional Concepts process to assess the potential for existing or emerging technologies to satisfy EOD mission needs. Notional Concepts are user-defined requirements whose ultimate aim is to produce an EOD tool or equipment item. The Notional Concepts process was created to facilitate development of new requirements, information flow, management decisions, and transition of funding from investigative research to sustained programs of record. Currently, there is no single site for the JSEOD community to receive, process, and manage Notional Concepts. The Naval Innovation Laboratory (NaIL) has a virtual work environment-based management information system for managing the U.S. Marine Corp's Urgent Universal Need Statements (UUNS,) a program similar to the JSEOD's Notional Concept program. The purpose of this report is to analyze the NaIL's Management Information System to determine if there are aspects of it that the JSEOD community could use to better manage the life cycle of their Notional Concepts.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACTD	Advanced Concept Technology Development
CAC	Common Access Card
CBVM	Capabilities Based Value Model
CDD	Capability Development Document
C/NDI	Commercial / Non-developmental Item
CNO	Chief of Naval Operations
CIP	Continuous Improvement Process
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities
DoD	Department of Defense
EO	Explosive Ordnance
EOD	Explosive Ordnance Disposal
EOD/LIC	Explosive Ordnance Disposal / Low Intensity Conflict
EUD	End-user Development
FY	Fiscal Year
IT	Information Technology
JCIDS	Joint Capability Integration and Development System
JIEDDO	Joint Improvised Explosive Device Defeat Organization
JRAB	Joint Improvised Explosive Device Resource and Acquisition Board
JSEOD	Joint Service Explosive Ordnance Disposal
JUONS	Joint Urgent Operational Needs
KM	Knowledge Management
MCCDC	Marine Corps Combat Development Command
MET	Mission Essential Task
MIS	Management Information System

MTAB	Military Technical Acceptance Board
NaIL	Naval Innovation Laboratory
NAVEODTECHDIV	Naval Explosive Ordnance Disposal Technical Division
NCWG	Notional Concepts Working Group
NMCI	Navy Marine Corps Internet
PDF	Portable Document Format
PIP	Product Improvement Process
PMS EOD	Program Manager (Surface) Explosive Ordnance Disposal
POR	Program of Record
R&D	Research and Development
RDT&E	Research, Development, Test, and Evaluation
TBD	To Be Determined
TRADOC	U.S. Army Training and Doctrine Command
USMC	United States Marine Corps
UUNS	Urgent Universal Needs Statement
VPN	Virtual Private Network
VWE	Virtual Work Environment
WBS	Work Breakdown Structure

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I. INTRODUCTION

Notional Concepts are a means for Explosive Ordnance Disposal personnel to communicate their needs for materiel solutions to overcome capability gaps in their assigned mission areas. It is their method of providing "user defined" requirements for the potential materiel solutions they may be provided with. In an effort to streamline the Notional Concepts process an analysis of the Naval Innovation Laboratory's Virtual Work Environment based Management Information System was undertaken to see how their system for managing Urgent Universal Need Statements from the Marine Corps is designed and operated. The objective of this analysis is to determine how the Naval Innovation Laboratory's system works, and if aspects of it can be implemented in a new Notional Concepts Management Information System. The outcome of this analysis will be recommendations for the Notional Concepts Working Group on which aspects of a Virtual Work Environment based Management Information System would enhance the management and development of Notional Concepts.

A. PURPOSE OF THIS ANALYSIS

American forces have been involved in combat operations overseas for eight years now, as of the writing of this thesis. Throughout Operations Iraqi and Enduring Freedom the world has witnessed an amazing rise in the employment and sophistication of Improvised Explosive Devices. Explosive Ordnance Disposal (EOD) Technicians have been at the forefront of the coalition battle against unexploded ordnance from the beginning. At home, those supporting their efforts from the realms of science, technology, politics, industry, and program management have sought to provide the EOD warfighters with improved equipment to enhance their fight and their survivability. An area that has received perhaps the most attention is the rapid acquisition of counter-IED technologies, and rightly so. Our EOD technicians need the best equipment that can be provided, and as soon as possible. Meanwhile, in the shadow of rapid acquisition are the processes that have always been in place to develop lasting equipment solutions for EOD technicians for every aspect of their broad mission, not just IED defeat. One particular

effort, Joint Service EOD Notional Concepts has been in use for over twenty years. The Notional Concepts process has remained relatively unchanged since its inception in 1989.

In early 2009, it was decided that the Notional Concepts process needed to be streamlined to reduce the life cycle of a Notional Concept by 50%. Such an undertaking would require the use of the best business practices available today. In particular, Lean Management and Six Sigma processes have been instituted to reach the 50% life cycle reduction goal. It has also been recognized that the share drive-based database for knowledge management and tracking Notional Concept development was in need of improvement as well. Improving the Management Information System could be accomplished in many ways. However, when the Virtual Work Environment based Management Information System in use at the Naval Innovation Laboratory was introduced to managers of the Notional Concepts process it showed such promise that it warranted greater evaluation. Thus, the analysis of the Naval Innovation Laboratory's Virtual Work Environment based Management Information System began to determine if such a system would be of benefit to the Joint Service EOD community's Notional Concept management process.

B. RESEARCH QUESTIONS

The primary research question for this analysis is whether the Naval Innovation Laboratory's Virtual Work Environment based Management Information System represents a capability needed by the Joint Service EOD community for managing Notional Concepts. The share drive-based database currently in use has served the Notional Concepts Working Group well since it was implemented. It is the system that members of the Notional Concepts Working Group are familiar with and requires little training or investigation for new users to be able to make use of it. What's more, it does not require any additional funding beyond what is already expended to provide for operation of the Navy Marine Corps Internet already in place. Therefore, a deeper investigation is required to determine if a change in their Management Information System that will incur a greater cost to implement and educate personnel on is worthwhile.

Secondary research questions will help uncover the specifics of the Virtual Work Environment based Management Information System to determine its potential utility for managing Notional Concepts. The following specific aspects will be considered to determine if such a Management Information System is needed for Notional Concepts management.

First, does the Virtual Work Environment based Management Information System represent a substantially greater capability for managing Notional Concepts? The Notional Concepts Working Group need go no further with a new Knowledge Management System if it does not provide a substantially better platform for data storage, information generation, information display, and decision support.

Second, would a Virtual Work Environment allow for greater access to information for participants in the Notional Concept development process? As will be discussed in Chapter III, Current JSEOD Notional Concepts Management Information System, most of the personnel who need access to the Notional Concepts database are co-located at the Naval Explosive Ordnance Disposal Technical Division. Since that is the case, do they or others who may have a need of information in their database need additional access capability?

Third, would a new Management Information System enhance the decision making process for Notional Concepts managers? Use of a new Knowledge Management System does not change the data or information that is used as an input into the system. It has to be determined if the Virtual Work Environment based Management Information System does, or is capable of doing, something different with data and information that the share drive-based Management Information System cannot. Will managers be able to better understand their programs or the information concerning their programs?

Finally, would a new Joint Service EOD Notional Concepts Management Information System enhance the development of Notional Concepts? Regardless of the Knowledge Management System personnel who process Notional Concepts use the same information is used to start the process. Thus, in order to enhance the development of Notional Concepts a new Management Information System would have to drive the input

data and information in a different way than the existing database system does. Can the Notional Concepts Working Group create, display, and analyze decisional information differently (better) with one system than they could with the other? Will a new Management Information System improve the Notional Concepts process? That's the bottom line.

C. ADDITIONAL INFORMATION

Neither the Naval Innovation Laboratory nor the Naval EOD Technical Division was visited to analyze their respective systems. Therefore, this analysis tested the ability of geographically separated users, with access permissions and security credentials, to make use of the Management Information Systems relied on for routine work.

It is helpful to point out that the Navy has been designated as the Single Service Manager for Explosive Ordnance Disposal Technology and Training for the Department of Defense (DoDD 5160.62, 1989). Thus, all of the Joint Service EOD Notional Concepts are developed at the Naval EOD Technology Division at Indian Head, Maryland. Representatives from each of the four service branches are located there for this purpose.

Finally, it is important for readers to have the EOD mission to aid in their understanding of what is at stake for those EOD Technicians waiting on the receiving end for new equipment to fulfill their EOD mission. "The EOD mission is to provide the capability to neutralize hazards from EOD incidents, which, because of unusual circumstances, present a threat to operations, installations, personnel, or materiel" (OPNAVINST 8027.1G, 1992). EOD incidents are those that involve "The detection, identification, field evaluation, rendering-safe, recovery, and final disposal of unexploded explosive ordnance (UXO). It may also include the rendering-safe and or disposal of EO, which has become hazardous by damage or deterioration, when the disposal of such EO requires techniques, procedures, or equipment, which exceed the normal requirements for routine disposal (OPNAVINST 8027.1G, 1992).

II. BACKGROUND

A. THE PURPOSE OF NOTIONAL CONCEPTS

The Notional Concept program is not an acquisition program. Its purpose is to provide "user defined requirements" to the Joint Service Explosive Ordnance Disposal (JSEOD) community for evaluation. (The word "requirements" here does not have the same connotation as it would in the Capability Development Document (CDD) of a program of record.) Notional Concepts are ideas that JSEOD technicians and engineers have for solving EOD mission capability gaps. The Notional Concept process serves to collect these good ideas, and facilitates the communication, exploratory development, and demonstration necessary to determine if state of the art technology can deliver hardware solutions to fill the identified JSEOD mission capability gaps. This process promotes the selection of project ideas with the technological maturity needed for program acquisition nomination.

Submission of a "Notional Concept" is one means for personnel in the JSEOD program to communicate their need for new tools and equipment solutions to complete the JSEOD mission. Notional Concept submissions describe the requirements that a new system, tool, or equipment item must meet in order to resolve a gap in EOD capability (PA 00-1, 2000). Notional Concepts are not for the development of new tactics, training, or procedures that could be used to resolve EOD problems. Neither are they justifications for purchasing existing equipment items. Their purpose is to research and/or develop new material solutions for EOD problems for the JSEOD community (PA 00-1, 2000).

Notional Concepts are for persistent programs that do not require expeditious acquisition. The Notional Concepts program predates the Department of Defense's (DoD) Joint Urgent Operational Need (JUON) process and other service specific rapid acquision processes. Well before Operations Enduring and Iraqi Freedom began, the Notional Concepts process was implemented as the means for communicating user-defined requirements in preparation for program acquisition. The dramatic rise in the use of Improvised Explosive Devices (IED) and the speed at which IED technology improves

has created a need for a more rapid response on behalf of the DoD acquisition system – especially where development of counter-IED technologies are concerned. The Joint Improvised Explosive Device Defeat Organization (JIEDDO) was created, in part, to meet this need. The JIEDDO Director is advised of JIEDD acquisition matters by the senior level JIEDD Resource and Acquisition Board (JRAB) that monitors the progress of JIEDD programs of record as they progress through the Joint Capabilities Integration and Development System (JCIDS) process (DODI 2000.19E, 2006). These efforts help to ensure that counter-IED programs of record sponsored by JIEDDO are resourced and fielded very quickly in response to urgent operational need.

B. THE NOTIONAL CONCEPTS PROCESS

1. Program Guidance

The process for submission, review, acceptance, and completion of Notional Concepts is governed by one document – Policy Agreement 00-1, Guidelines for Preparing, Submitting, and Processing Notional Concept Papers. Policy Agreement 00-1 originates from the Assistant to the Executive Manager, DoD EOD Technology and Training (CNO N85XA) and is signed by the EOD Program Board member of each of the four service departments.

2. Who Can Submit a Notional Concept

Notional Concepts can originate from persons at any level within the JSEOD community's service branches or from within the Naval Explosive Ordnance Technology Division (NAVEODTECHDIV) itself. Any EOD technician that perceives a gap in the JSEOD community's ability to perform its mission can submit a Notional Concept paper within his or her service branch to propose a material means of resolving the gap. Likewise, persons within NAVEODTECHDIV who identifies a capability gap and suggests a materiel means for resolving a known capability gap can provide a Notional Concept submission to the necessary service detachments at NAVEODTECHDIV for sponsorship (PA 00-1, 2000).

3. Submission Requirements

There is currently no required format for the submission of a Notional Concept paper. The individual services are free to set policy for paper formatting. There is, however, some minimal guidance on the required content for Notional Concept submissions. Policy Agreement 00-1 sets forth the following for the submission requirements:

- Statement of the requirement
    - Mission to be performed
    - Threat to be encountered
    - Need justification for new or improved hardware item
- Identification of the activity submitting the Notional Concept
- Point of Contact (PA 00-1, 2000)

Additional information such as the anticipated operating environment, constraints, or alternate solutions already in development that is known should also be provided in the submission (PA 00-1, 2000).

4. The Notional Concepts Process

As mentioned above, the Notional Concept submission process begins with a potentially good idea to resolve a JSEOD mission capability gap (see Figure 1). The Notional Concept developer describes his or her idea in a paper according to Policy Agreement 00-1, then sends the paper through their service branch for review and submission to their service detachment representative at NAVEODTECHDIV. The service detachments at NAVEODTECHDIV are comprised of active duty personnel from each of the four service branches. Notional Concepts received by any service detachment will be socialized with the other service detachments to assess initial interest in joint service applicability and sponsorship. Notional Concepts that do not receive joint interest can be returned to their originator or the service detachment may individually sponsor the

submission for their parent service branch. Submissions returned to their originator can be further developed for later resubmission (see Figure 1).

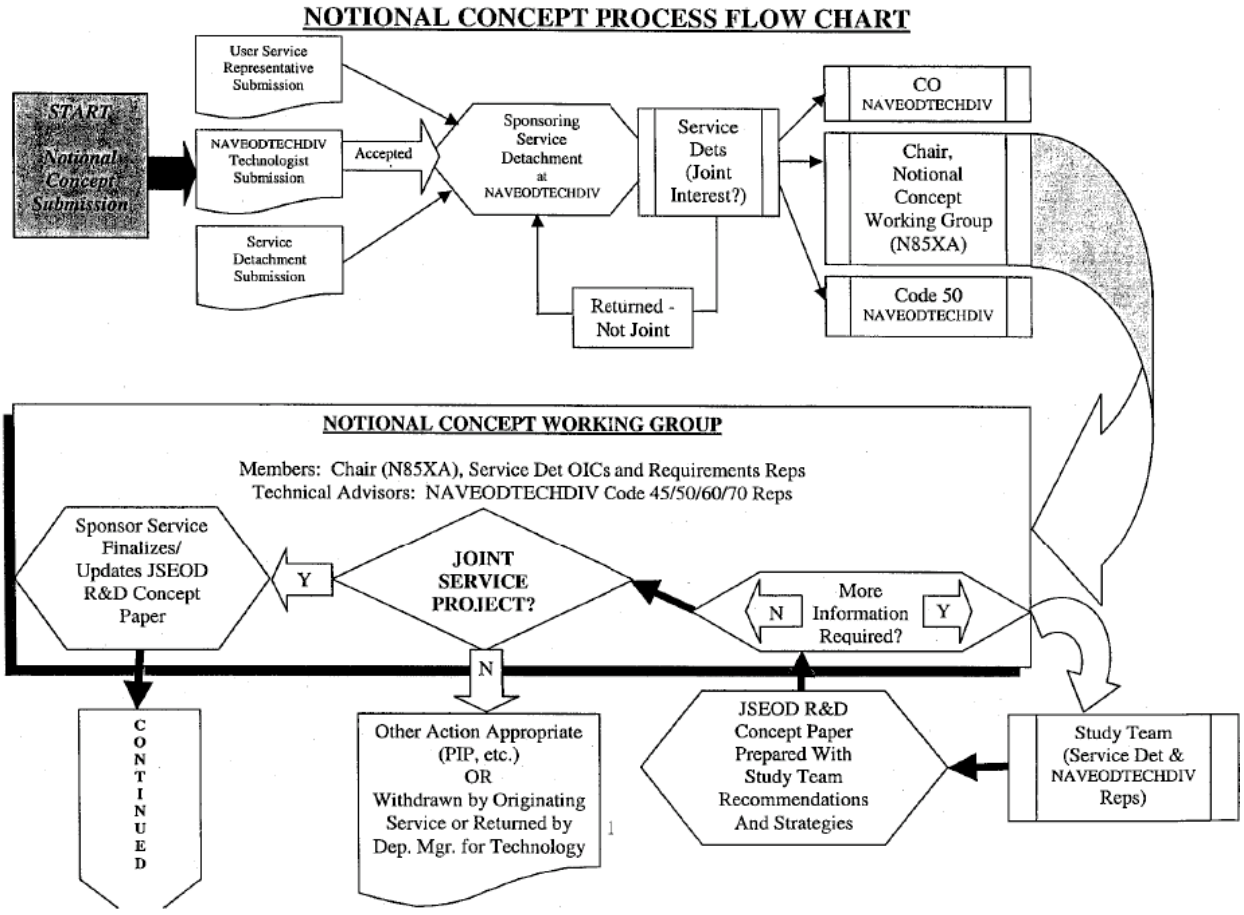

Figure 1. The Notional Concepts Process Part 1 (From PA 00-1, 2000)

Submissions that receive joint interest or that will be sponsored by a single service are then provided to the Notional Concepts Working Group (NCWG) Chairperson and to the other service detachments. The Chairperson will then assign a control number to the Notional Concept and *"maintain records to reflect its status"* (PA 00-1, 2000).

The NCWG, chaired by N85XA and comprised of the service detachment commanders and a representative from the Army's Training and Doctrine Command,

meets quarterly to consider new and pending Notional Concepts. As necessary, NCWG meetings can be convened outside of the normal quarterly schedule and further actions can be coordinated by e-mail. The NCWG will consider the information available to them regarding the Notional Concept, to include:

- Its applicability to the requirements of each of the services
- Feasability under new or emerging technology
- Availability of current systems to meet the capability need
- The appropriate system design requirements and thresholds
- Similar research and development projects already underway
- Whether the given information is sufficient to recommend a course of action

To facilitate the work and decisions of the NCWG, the service detachment submitting the Notional Concept will support the process, as follows.:

- Provide outside technical representatives to help review submissions
- Present and explain the Notional Concept they have submitted
- Describe an approach for developing the Notional Concept
- Provide the necessary documentation

5. Outcomes of the Notional Concept Working Group

There are three major outcomes from the NCWG concerning submitted Notional Concepts. Each decision carries with it a need to either continue tracking a submission's movement through the Notional Concept process or to maintain a document of a unanimous decision against a submitted Notional Concept.

If a Notional Concept comes before the NCWG and is unanimously rejected for joint EOD sponsorship or applicability, then the service detachment that proposed it has two choices for its disposition (see Figure 1). First, it may wholly withdraw the submission. This would effectively end the submission. The second option is to have the

Notional Concept returned to the parent service via the Deputy Manager for Technology on behalf of the Program Board (PA 00-1, 2000). This action demonstrates that a service attempted to provide the Notional Concept for JSEOD use but was rejected for joint applicability. The service is then allowed to pursue the Notional Concept as a service-unique requirement (DoDD 5160.62, 1989).

Should the NCWG not be able to reach a consensus decision regarding the proper disposition of a new submission then the NCWG will refer the Notional Concept to the EOD Action Officers for determination for JSEOD applicability. If the EOD Action Officers determine that the submission does meet joint needs, then the NCWG will process the submission favorably. If not recommended by the EOD Action Officers, then the Deputy Manager for Technology will return the submission to its originator (PA 00-1, 2000).

If the NCWG determines that there is not sufficient information to process a Notional Concept decision, then they can form a study group comprised of NAVEODTECHDIV's Code 50, PMS EOD (the EOD program office), and the service detachments to collect further information and develop options for the decision on the new submission (PA 00-1, 2000).

Submissions that are unanimously approved by the NCWG will be assigned to one of several Joint Service Research and Design (R&D) projects for development. Assignment to one of these various R&D projects for acquisition is based on technological maturity of potential solutions, and commercial availability (see Figure 2).

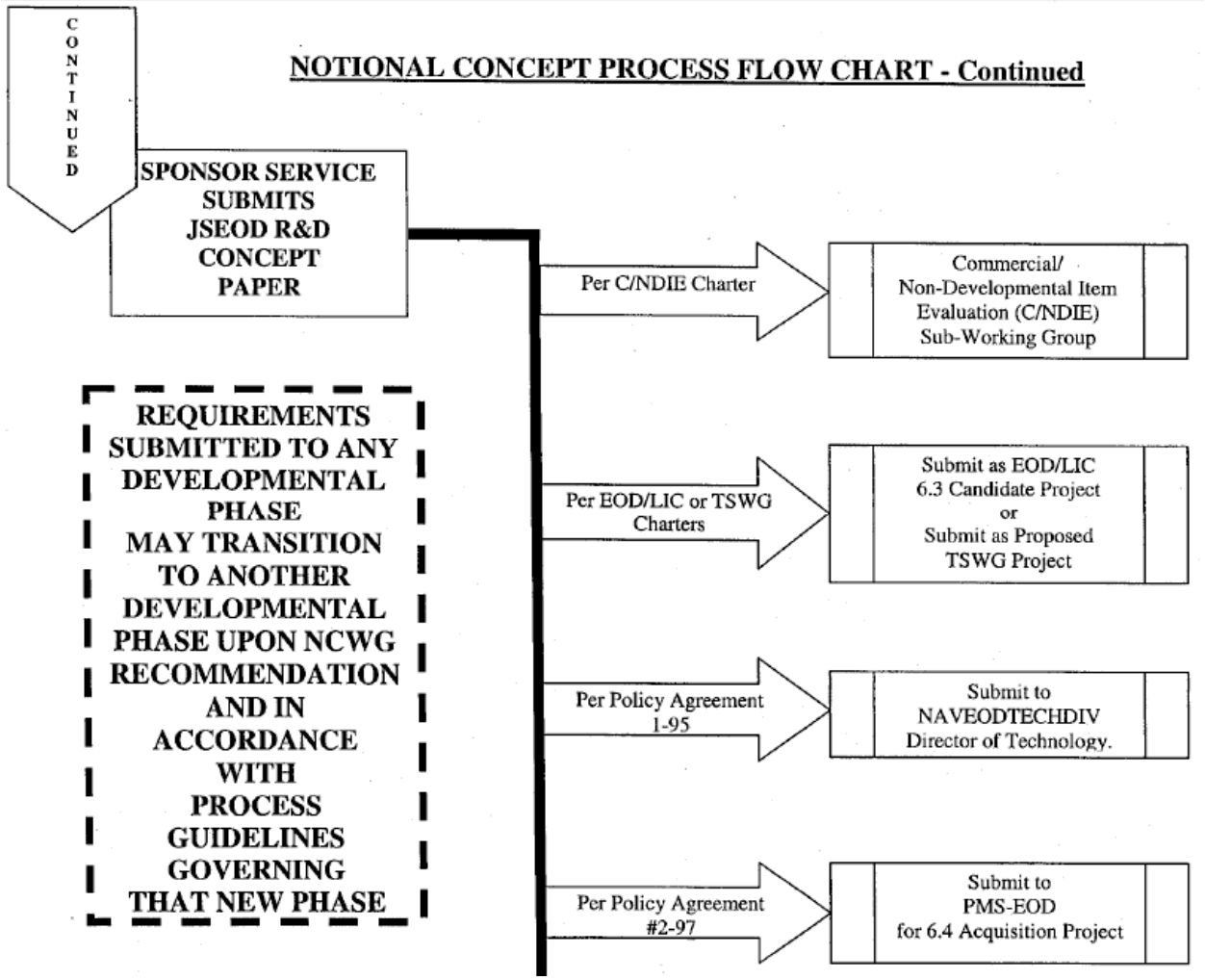

Figure 2. The Notional Concepts Process Part 2 (From PA 00-1, 2000)

6. Joint Service Project Types

C/NDI: The "best case" for providing a technologically feasible materiel solution would be for it to already exist outside of the JSEOD community. This is the "Commercial/Non-Developmental Item" (C/NDI) (see Figure 2). Obtaining potential C/NDI solutions for testing and demonstration of technical capability saves time and resources since the base technology has already been established. The NCWG maintains a C/NDI sub-Working Group to evaluate commercial and non-developmental items for use by the JSEOD community. The C/NDI sub-Working Group is made-up of various

codes from within NAVEODTECHDIV, PMS EOD, and the service detachments. They report their findings to the NCWG in writing at the quarterly NCWG meetings.

Applied Research Program (6.2): If there is no C/NDI solution available then the NCWG may recommend that development of the Notional Concept begin as an applied research program (PA 00-1, 2000). Applied research programs are typically referred to as "6.2 funds" or a "6.2 account" (see Figure 2). They support the exploratory development of new technologies for specific military applications or further development of existing technology for new military applications (The Coalition for National Security Research, 2001).

Technology Demonstration Program (6.3): Another alternative for the NCWG is the use of "6.3 funds" for a technology demonstration (advanced technology development) of a potential material solution to resolve a capability gap (PA 00-1, 2000). Advanced Technology Development supports larger scale hardware development, integration, and experiments that can demonstrate capability in more operationally realistic settings (The Coalition for National Security Research, 2001). These demonstrations are sometimes used to test the feasibility of items developed under the Applied Research Program (6.2) to demonstrate that they are mature enough to advance to the Demonstration and Validation phase (6.4). The NCWG can offer the Notional Concept as either an EOD/LIC (Explosive Ordnance Disposal/Low Intensity Conflict) or TSWG (Technical Support Working Group) demonstration (see Figure 2).

When Notional Concepts that were addressed by either the 6.2 (applied research) or the 6.3 (technology demonstration) programs are nearing the completion the NCWG has to determine if they will be nominated to become programs of record (see Figure 2). If so, then communications with the EOD Program Manager will begin as early as possible to start the process for establishing funding in the Program Objective Memorandum (POM) for an acquisition program for the system. The (now completed) Notional Concept will then enter into the JCIDS process according to the requirements of the Joint Capability Integration and Development System.

C. THE NEED FOR TRACKING AND MANAGEMENT OF NOTIONAL CONCEPTS

At any given time, there are dozens of Notional Concepts in process. The Notional Concepts may be those that have just arrived into the system and are awaiting their first review, those that have been accepted and are awaiting funding decisions, and those that are active in the process—involved in applied research or technology demonstration. Managing so many submissions in process at the same time, across multiple stages of review, and awaiting action by various services and organizational elements (that have their own unique processes) requires a sophisticated system.

According to Policy Agreement 00-1, if there is joint interest in a Notional Concept submission then the NCWG Chairperson, N85XA, "will assign a control number to the submission and *maintain records* to reflect its status" (PA 00-1, 2000). (It is important to note that chairing the NCWG is just one of many duties of N85XA. The other members of the NCWG are also in the group by virtue of their primary job as a representative of their service department at NAVEODTECHDIV). Policy Agreement 00-1 establishes the requirement for tracking Notional Concepts throughout their lifespan but does not prescribe a method for doing so except for use of a control number.

Another reason to track and manage Notional Concepts is that the NCWG is scheduled to meet only quarterly. An Equipment Review Board (ERB) meets bi-weekly to continue processing only the active Notional Concepts (i.e., those that have been assigned to 6.2 or 6.3 for R&D). The ERB tracks active Notional Concepts on a spreadsheet. It would be impossible for all of the necessary work required to develop Notional Concepts to be accomplished during these infrequent meetings. Thus, if outside work is necessary to continue moving the Notional Concepts forward, then there must be a means to manage the work in process and report on the work that has been done during the intervening periods.

D. VIRTUAL WORK ENVIRONMENTS

A Virtual Work Environment can be defined as "an adaptable, integrated, shared community workspace where co-located or distributed people can collaborate, work on

tasks, and solve problems cooperatively using organizational intellectual capital (knowledge) and processes virtually" (Virgina Department of Social Services, 2006). This useful definition makes clear both the purpose and the process of a Virtual Work Environment (VWE). The Director of Knowledge Management Integration for the Marine Corps' Combat Development Command describes three levels of increasing service that a VWE can provide within an organization as follows:

- An alternative space where knowledge workers can conduct their normal work assignments,
- An alternative space where teams, business units, and major organizational divisions can conduct and manage their mission goals and objectives, and
- An alternative space to conduct business with outside organizations, partners, customers, and contract support (Simmons, 2006)

A VWE provides for project work and management by thoughtfully organizing and displaying project information for all users. Users can have access to part or all of the information within the system and its many features (e.g., document retrieval, video tele-conferencing, scheduling services) to accomplish their work. In the VWE several necessary business functions are accomplished.

- The VWE provides for a single repository of all information that is relevant to a given subject(s). Every article of information that can be captured electronically is maintained in a single site. Documents containing information such as funding requirements, expenses, decision points, and schedules are all made available in one location. Multiple stakeholders are provided appropriate access to information from a shared or common database at all times.
- Document and data management are made simple because a single change is all that is required to make a system-wide update. When new documents are added they are immediately available to all system users. Changes in a program's status, graphical depictions, and displayed summary tables require only a single person's effort to update in order for all system users to be

presented the most current information at their workstation – regardless of location.

- Providing a single site for information collection allows users to perform reliable database searches. Because all relevant program information is kept in one location, it is much easier for users to perform a "system-wide" search. Users can quickly find all information for a given program or a particular area of interest that is common across multiple programs.
- A single site for information sharing removes the boundaries normally associated with compartmentalized organizations. For example, the Logistics Department has access to the same information as the Operations Department, and the Finance Department will have the same information as the other departments. This is also true of spatially separate organizations and team members. Organizations that have displaced departmental functions have access to the same information. Team members from other organizations also have access to the same information. Organizational and physical boundaries to information access are removed by use of a VWE. This greatly improves the opportunity to collaborate on projects, share opinions, identify and make corrections to information, and keep all team members engaged in ongoing processes.

Virtual Work Environments seek to improve business processes. The goal is to provide all team members with access to the same data, to display the same graphical representations, to provide scheduling notifications, virtual meetings, and so forth. VWEs provide for greater information accuracy. There is far less replication of information when it is added to a VWE than there is when it is continually shared by team members via e-mail or share drives. Additionally, VWEs improve information integrity. By removing barriers to information, increasing the accuracy of the information, and improving team member collaboration, the VWE enhances business processes.

E. MANAGEMENT INFORMATION SYSTEM

> *"A management information system (MIS) is a system or process that provides the information necessary to manage an organization effectively. MIS and the information it generates are generally considered essential components of prudent and reasonable business decisions."*
>
> *– (Comptroller of the Currency, 1995)*

Where the VWE provides the foundation for information access and collaboration, the MIS provides the architecture for information generation. For the NCWG, that may take the form of calculations and graphing functions. The following factors are described in the Comptroller's Handbook, issued by the Office of Comptroller of the Currency, Administrator of National Banks, as the bedrock requirements for a successful MIS (Comptroller of the Currency, 1995):

> Timeliness—To simplify prompt decision-making, an institution's MIS should be capable of providing and distributing *current* information to appropriate users. Information systems should be designed to expedite reporting of information. The system should be able to quickly collect and edit data, summarize results, and be able to adjust and correct errors promptly.
>
> Accuracy—A sound system of automated and manual internal controls must exist throughout all information systems processing activities. Information should receive appropriate editing, balancing, and internal control checks. A comprehensive internal and external audit program should be employed to ensure the adequacy of internal controls.
>
> Consistency—To be reliable, data should be processed and compiled consistently and uniformly. Variations in how data is collected and reported can distort information and trend analysis. In addition, because data collection and reporting processes will change over time, management must establish sound procedures to allow for systems changes. These procedures should be well defined and documented, clearly communicated to appropriate employees, and should include an effective monitoring system.
>
> Completeness—Decision makers need complete and pertinent information in a summarized form. Reports should be designed to eliminate clutter and voluminous detail, thereby avoiding "information overload."

> Relevance—Information provided to management must be relevant. Information that is inappropriate, unnecessary, or too detailed for effective decision-making has no value. MIS must be appropriate to support the management level using it. The relevance and level of detail provided through MIS systems directly correlate to what is needed by the board of directors, executive management, departmental or area mid-level managers, etc. in the performance of their jobs.

The majority of the items listed above would be applicable to any organization regardless of their product or process. These five factors would be suitable for any military organization as well. For the purposes of a MIS for the JSEOD NCWG there would not need to be such an emphasis on auditing, as that applies more to the banking applications the Office of Comptroller of the Currency oversees. That does not remove the need for management and oversight of a MIS if used by the NCWG.

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III. THE CURRENT JSEOD NOTIONAL CONCEPTS MANAGEMENT INFORMATION SYSTEM

A. FRAMEWORK

The Management Information System (MIS) currently in use for Notional Concepts consists of a database of electronic folders and subfolders that store all information associated with the Notional Concepts program. The database allows for limited access to the documents and spreadsheets that describe each of the Notional Concepts and their status.

1. HARDWARE

The Notional Concepts database is contained entirely in the electronic NCWG folder maintained on a share drive at NAVEODTECHDIV. The share drive is maintained as an element of the Navy-Marine Corps Internet (NMCI) system at NAVEODTECHDIV. Any NMCI workstation that has a Common Access Card (CAC) reader can be used to access the share drive provided the individual seeking access has been authorized entry to the NCWG folder.

2. SOFTWARE

Standard Microsoft Office productivity programs (e.g., Word, PowerPoint, and Excel) and an Adobe portable document format (PDF) reader are all the software an individual needs in order to view or edit the data contained in the NCWG folder. A "navy.mil" e-mail address and the proper credentials (maintained on the individual's CAC) are also required in order to access the NCWG.

B. OWNERSHIP

The NCWG Chairman is responsible for the development, content, and access control to the NCWG folder. The NCWG Chairman is the Assistant to the Executive Manager, DoD EOD Technology and Training. Policy Agreement 00-1 requires that the

NCWG Chairman maintain records of all Notional Concepts. Maintenance of these records is but one of the chairman's NCWG duties, just as chairing the NCWG is but one of the many duties of the Assistant to the Executive, DoD EOD Technology and Training.

Two personnel assist the NCWG Chairman with records maintenance duties. A government civilian employee directly assists with the upkeep of the records in the NCWG folder. A civilian contractor is responsible for the ties between the NCWG folder and the Capabilities Based Value Model (CBVM) that is used by the EOD Program Office to prioritize acquisition efforts. The CBVM produces an acquisition effort prioritization based on the relative value of their functional capability. Relevant information on Notional Concepts that are pursued as programs of record will be provided to the CBVM system for inclusion.

C. ACCESS

All personnel who are members of the NCWG should have the necessary permissions to access the NCWG folder for the purposes of their work. However, difficulties arise in this arena because not all members of the NCWG are located at NAVEODTECHDIV or have an e-mail address from the "navy.mil" domain. For example, the U.S. Army Training and Doctrine Command (TRADOC) representative requires access to the NCWG folder as a standing member of the NCWG, but cannot access the database due to not having a "navy.mil" e-mail address. The TRADOC representative to the NCWG, displaced from NAVEODTECHDIV by 150 miles, has no means to access data on a Notional Concept other than requesting it by e-mail or fax. The same would be true for any others seeking information on a Notional Concept that did not have an NMCI workstation and a "navy.mil" e-mail domain.

Only the NCWG Chairman and immediate staff, NAVEODTECHDIV Code X (see Figure 3), have NCWG folder and document editing permissions. Read only access to the NCWG folder is given to the following other NAVEODTECHDIV entities (see Figure 3):

- Service Detachments (USA, USAF, USMC, and USN)
- Code 20 – Information Management Department
- Code 50 – Acquisition and Technology Department
- Code 70 – Joint Service EOD Program Management

Reserving folder-editing capability at the chairman's level ensures that all records for Notional Concepts are tracked according to Policy Agreement 00-1 and that all changes to documents and spreadsheets are authorized.

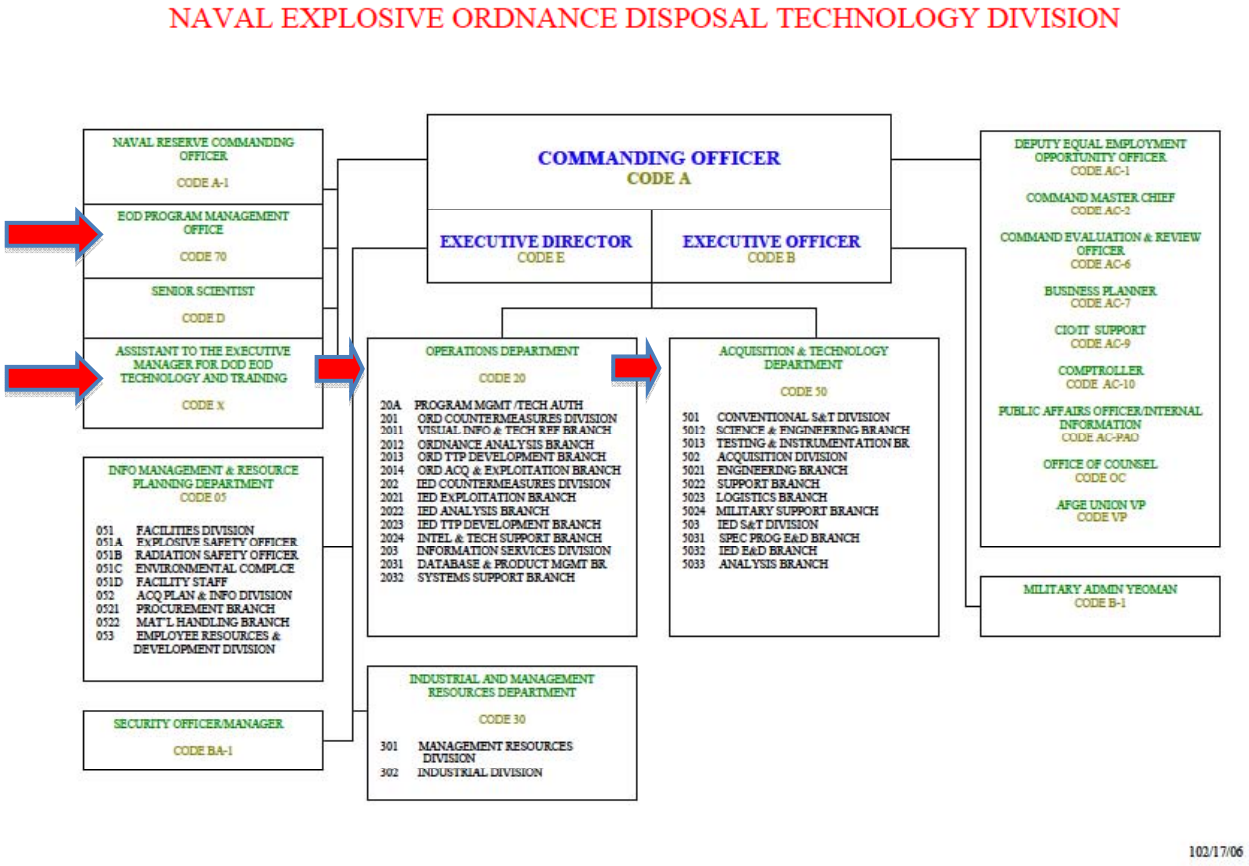

Figure 3. NAVEODTECHDIV Organization Chart (From NAVEODTECHDIV, 2009)

D. NCWG FOLDER CONTENT

The NCWG folder is the primary tool for managing JSEOD Notional Concepts. It contains all Notional Concept papers (past and present) as well as meeting minutes from

past NCWG meetings, a Notional Concept log, a Notional Concept Status Report, and an agenda for the next NCWG quarterly meeting. Each of these items provides a piece of the information necessary to understand the full scope of the Notional Concept program and the status of the individual Notional Concepts. A description of each item follows.

1. The Agenda Subfolder

The Agenda subfolder maintains a copy of the agenda for the next scheduled NCWG quarterly meeting and several agendas from recent meetings. The agenda, which is delivered by standard mail or e-mail to NCWG participants and then filed in the NCWG folder, provides the basic information to inform meeting participants of the next meeting's time, date, and location. But the agenda also performs a minimal amount of Notional Concept management.

First, it specifically lists action items and pending items from the last NCWG meeting that will be discussed. This function of the agenda gives notice to personnel who have the responsibility to provide an update of the Notional Concept(s) they sponsor or action items that they have been assigned. Notional Concepts are most effectively advanced through the system by continued pressure to show progress on action items between NCWG quarterly meetings. Tracking of active Notional Concepts is currently best accomplished by comparing the current status of its action items against their status from the previous meetings.

Second, at each quarterly meeting, one of the four service detachments will provide an update of all active Notional Concepts that their service is sponsoring. This rotation allows each service to fully update approximately 15–30 active Notional Concepts each year.

Finally, the agenda also lists the *new* Notional Concepts that are to be considered by the NCWG. Participants can find information on these new Notional Concepts in the NCWG subfolder for the current fiscal year's new submissions.

2. The Meeting Minutes Subfolder

The Meeting Minutes subfolder maintains a copy of the meeting minutes from several of the most recent NCWG quarterly meetings. The most important of these is the minutes from the most recent quarterly meeting. In it are the details of the briefings given, Notional Concepts updated, and other various discussions, recommendations, and decisions that were made during the meeting. The meeting minutes document the assignments made to NCWG members for action. Managing these action items is very important for bringing Notional Concepts to completion. Examples of such action items are as follows:

- Rewriting Notional Concepts to include the recommendations of the NCWG
- Combining two or more Notional Concepts that are similar or have overlapping capability
- Reporting test results
- Determining and reporting funding availability for specific Notional Concepts

The Meeting Minutes subfolder, like the Agenda subfolder, provides a means for members of the NCWG to re-visit items of interest concerning the quarterly meetings of the NCWG.

3. The Notional Concepts Subfolder

This subfolder contains a folder for each fiscal year (1990–2009.) Each of these folders stores the Notional Concept papers that were submitted during that particular fiscal year. The Notional Concept folders do not contain all of the information particular to a specific Notional Concept. All of the information used to manage the Notional Concept is maintained in the Notional Concept Status Report.

4. The Proposed Notional Concept Subfolder

This subfolder functions exactly as its name implies. It simply stores all the information relevant to newly proposed Notional Concepts until they have been reviewed by the NCWG for acceptance or other action.

5. The Notional Concept Status Report

The status report is currently a forty-plus page Microsoft Word document in table form that provides a commentary on the status of every Notional Concept in the program's history. The report is organized according to the status of the Notional Concepts. There are six status groupings:

- Pending Notional Concepts
- Notional Concepts in 6.2 programs
- Notional Concepts in 6.3 programs
- Notional Concepts that have been accepted into a 6.4 program
- Notional Concepts in C/NDI, Continuous Improvement Process (CIP), or Product Improvement Process (PIP).
- Notional Concepts Completed, Withdrawn, or Closed-Out

The following information is provided for each Notional Concept:

- Notional Concept control number
- Equipment nomenclature (name)
- Sponsoring service
- Status – A history of all action taken on behalf of the Notional Concept, recommendations, additional information required, and actions in progress

The NCWG Status Report is a basic document. There are no graphs or comparison tables to demonstrate a particular Notional Concept's progress or funding needs and expenditures. There are no hyperlinks that bring-up the original Notional

Concept submission for a full description of the given system or its need. Each Notional Concept is described individually. They are not, and cannot be, sorted according to function, sponsor, or commonalities.

6. The Notional Concept Log

The Notional Concept Log is a simplified version of the NCWG Status Report, but it is provided on a Microsoft Excel spreadsheet. Notional Concepts are arranged according to the year they were received and numerical order. There is a hyperlink to the original Notional Concept submission, which describes the equipment item and its need. In addition to the nomenclature and link to the paper, there is short descriptor of the program's status. Unlike the NCWG Status Report that nicely grouped efforts according to just six status categories, the Notional Concept Log lists at least eighteen possible descriptions of status. For example:

- Completed, Closed, Withdrawn, Cancelled
- On-going, In-progress
- Pending, On-hold, TBD
- Merge with and close, Consolidate with, Refine design or close, Rewritten
- New, New-ongoing
- C/NDI, CIP
- Move to 6.4

E. EFFECTIVENESS

For the purposes of data storage the current system of folders and subfolders is sufficient. The Notional Concept papers (the original submissions) are logically categorized, and an excellent historical record has been maintained. There are, however, issues with content, presentation, and information access.

There are no managerial decision aids concerning the individual Notional Concepts or the program as a whole. For instance, there are no schedules for completion

for any of the Notional Concepts. There is no mention of desired completion dates for any of the active projects in either the NCWG Status Report or the Notional Concept Log.

Along with content, presentation of the material was found to be fairly basic. Having to sort through a forty-page status report to find an update on a project is time consuming, and does not allow for useful comparisons of like projects, project categories, or service specific projects. This method also requires precise knowledge of the system's nomenclature in order to locate it quickly. There are no graphics to quickly summarize project funding, progress, or schedule adherence.

Finally, data access is unsatisfactory. The Notional Concepts program is a Joint Service EOD effort. The name alone implies wide-ranging participation from geographically separated organizations. Having access to the NCWG folder blocked to all personnel without an NMCI address is unacceptable. Limiting access to only NAVEODTECHDIV personnel prevents sharing ideas and information with the majority of the JSEOD community that works outside of NAVEODTECHDIV. This includes personnel from all four-service branches because some U.S. Navy personnel will not always have a "navy.mil" address (i.e., when deployed). The current system also excludes other federal agencies that DoD EOD would normally work with since they do not use NMCI, thus preventing collaboration with them. Recommendations for improving Notional Concepts knowledge management will be discussed in Chapter VII—Conclusion and Recommendations.

IV. ANALYSIS OF THE NAVAL INNOVATION LABORATORY'S USMC UUNS MANAGEMENT INFORMATION SYSTEM

The Naval Innovation Laboratory provides an environment and process for analysis and evaluation of alternative technologies and development of potential solution strategies in response to urgent capabilities needs, and when requested manages Rapid Development and Deployment projects. (M. Jinnett, personal communication, October 20, 2009) The Naval Innovation Laboratory (NaIL) uses a Web-based Virtual Work Environment (VWE) as the Management Information System (MIS) for processing Urgent Universal Need Statements (UUNS). An Urgent Universal Need Statement is a request for a capability from a Marine Corps unit deployed or about to deploy to a combat theater that, "if not filled, places the accomplishment of the unit's mission in jeopardy or unduly increases the risk of casualties" (CMC, 2006). This definition reflects the time critical nature of the UUNS and helps explain why the MIS used to develop dozens of UUNS solutions simultaneously must be able to accurately store, generate, and display information that enhances discussion, analysis, and the managerial decision making process.

A. FRAMEWORK

1. HARDWARE

The NaIL VWE is a server-based system that resides on servers at the Naval Innovation Laboratory. There is no proprietary hardware necessary to operate the NaIL VWE. Thus, any organization with a network server would have the necessary hardware for a Web-based VWE. Hardware needed to access the NaIL VWE is simply a standard personal computer and a DoD Common Access Card (CAC) reader.

2. SOFTWARE

CorasWorks and Microsoft SharePoint are the primary software applications used to develop the MIS used by the NaIL. Microsoft SharePoint is "an integrated suite of

server capabilities that can help improve organizational effectiveness by providing comprehensive content management and enterprise search, accelerating shared business processes, and facilitating information-sharing across boundaries for better business insight" (Microsoft Corporation, 2009). CorasWorks Modular Application Development System for Microsoft SharePoint is an application that allows user-developers to "build Web–based solutions such as project– and process–oriented solutions and line of business applications." Using their "modular architecture makes it easy to design, build, and manage an integrated workplace of collaborative business applications, without the time and expense of custom development" (CorasWorks Corporation, 2009). The CorasWorks Modular Application Development System provides the following functions for both user-developers and consumers:

- User Interface—Build views, displays, navigation, and forms that make it easy for the user to see, contribute to, and act on data and information
- Application Services—Leverage business logic, timers/triggers, mashups (Web applications that aggregate information drawn from different sources), and data analysis in your processes and applications
- Data Services—Connect to data both within and external to SharePoint
- Admin / Management—Add immediate structure and control to your environment and applications (CorasWorks Corporation, 2009)

There are numerous other applications available that could have been used to develop the NaIL VWE. However, using this combination of SharePoint and CorasWorks software has allowed the NaIL to develop their own MIS. The members of the Information Technology (IT) Department accomplish the software installation and server set-up, but it is the user-developers of the MIS that are responsible for data input, information display, and all other content. A more detailed discussion of this arrangement and its benefits follows in the next section, Ownership.

B. OWNERSHIP

As mentioned above, the user-developers of the MIS are responsible for its management. Once the IT Department has the applications running on the servers the remaining work of building, populating, and maintaining the MIS belongs to its user-developers. The IT Department is solely responsible for the software and server maintenance and upgrades. This arrangement is riskier than contracting professional software development. Those risks will be discussed in Chapter V—Comparative Analysis.

While system coding is outside of the normal scope of MIS users, it has worked well at the NaIL for several reasons. First, since the IT Department does not use the MIS they are not responsible for building and maintaining it. This places the onus of proper development on the users of the system. Second, because it is user-developer built and maintained there are no costs for outside contractors to design, implement, or provide support services for the MIS. Eliminating outside support avoids tremendous costs for the NaIL. Users do not have to provide contractors with design information. They do not have to provide contractors with information to make alterations or upgrades, and they do not have to wait for upgrades to be designed or implemented. This method not only saves the NaIL time and avoids extra costs, but it also requires them to design the MIS how they want it. Since the NaIL personnel design the MIS, they are able to make the changes they want so that data is used and information is displayed optimally. Being responsible for entering the UUNS requirements information into the MIS also increases their exposure to the UUNS requirements, which increases the NaIL's corporate knowledge. Understanding the requirements better improves their ability to process the UUNS and provide the best solutions when the process is complete.

The engineering analysts who comprise the staff of the NaIL also maintain and use the VWE on a daily basis. When a new UUNS is received by e-mail, the staff will transfer the UUNS requirements from the e-mail to a blank UUNS template. Once the UUNS requirements are uploaded into the MIS, the UUNS analysis work will begin. Analysts develop and make use of the MIS information described below.

C. COMPOSITION OF THE NAIL VIRTUAL WORK ENVIRONMENT

Each UUNS is assigned to one of three primary categories—Research and Analysis, Pending Service Development Path Decision, and Rapid Development and Deployment Projects—based on the maturity of the technology associated with the UUNS. The NaIL VWE provides a quick-look function that allows any authorized user to click on the primary category, such as Research and Analysis, and collectively see the status of each of the UUNS assigned to that category. From this point the VWE user can see which analyst has been assigned each UUNS and what the progress rate is for each sub-task. Managers can also use this section of the VWE to see all of the UUNS that each analyst has been tasked with. Managers can make additional assignments by selecting an unassigned UUNS and designating it to an individual analyst.

The VWE user can examine the specific information of a particular UUNS by using the primary category drop-down list and simply selecting the UUNS of interest. Clicking on the individual UUNS link will navigate to a separate page dedicated to that particular UUNS where all of its detailed information is available. Each UUNS Web page is designed such that a series of ten "page tabs" is displayed across the top of the page. The following list provides a general description of the information that can be made available for each UUNS, as organized on its unique Web page.

- Summary Page
    - Description of the urgent need
    - Structured summary of the decisions made for the individual UUNS
    - Structured summary of the potential solutions for the urgent need
    - Color-coded display of schedule adherence
    - Graphical representation of task status (percent complete)
    - List of other organizations collaborating with
- Initial Posting Page—describes who identified the urgent need and describes the need

- Planning and Schedule Page—color coded display of progress for each of the eight phases of the NaIL's assessment
    - Initial Posting
    - Planning Schedule
    - Urgency Check
    - Required Capabilities
    - Market Research
    - Comparative Analysis
    - Technology Readiness Level (TRL) Calculation
    - Solution Strategy
- Urgency Check Page—requesting unit's deployment date, mission impact, and urgency verification/justification
- Required Capabilities Page—lists required capabilities, prioritizes required capabilities
- Market Research Page—lists possible technological solutions, manufacturers, manufacturer contact information, and relevant documents
- Comparative Analysis Page—Assesses each potential technological solution against the stated/implied requirements capabilities
- Technology Readiness Level Page—Analysis of the potential technological solution's readiness
- Solution Strategy Page—Provides a comprehensive comparison of the potential technological solutions based on: comparative analysis result, required capability suitability rating, mission execution rating, cost-benefit ratio, risk (based on TRL), estimated cost, and any other justifications

- Journal Page—A comprehensive display of e-mail, meeting, and phone conversation content that would normally be kept in an individual's e-mail, journal, or memory

These are the major categories of information presentation provided by the NaIL MIS. They were designed by the same user-developers who have to rely on the embedded calculations, graphical representations, data comparisons, and information summaries to make final determinations of which technology to recommend as the solution to the UUNS. If there was an information group, calculation, or method of displaying information lacking from that described above, the NaIL VWE user-developers could simply develop and implement the solution they desired.

In addition to data functions and technical information display the NaIL VWE also performs additional duties normally found in separate collaboration applications. The VWE provides calendar functions, such meetings and completion dates, e-mail, and project tasking and reporting. Other VWE systems can also provide video chat capabilities. Video chat was not a feature found in the NaIL VWE.

D. ACCESS

Access can be given to virtually anybody with the DoD, whether military or civilian, provided they have a basic personal computer, Internet access, Microsoft Internet Explorer (6.0 and above recommended), a DoD common access card (CAC), and a DoD CAC reader can access the NaIL's VWE if given permission. Because the system is Web-based and server operated it does not require the general user to have any SharePoint services compatible applications. Such connectivity allows for users anywhere in the world to access the NaIL VWE as effectively as if they were working within the "brick and mortar" structure housing the Naval Innovation Laboratory.

Personnel accessing the site remotely have the same permissions for data entry and review as they would if they were at the NaIL's physical location. NaIL engineers accessing the system remotely have the same development capability as local users. Remote users who are strictly consumers of the information generated by the NaIL MIS

would also have the same level of access as local users. Also, the VWE collaborative functions such as e-mail, calendars, and tasking would still be available. The effectiveness of those tools would only be affected by bandwidth and security firewalls, both of which depend on user location and system performance and are independent of the VWE.

E. CONTENT

The information presented in the NaIL's MIS is what the user-developers have determined to be necessary for their analysis of USMC UUNS. The dedicated page for each UUNS will display whichever of the ten page tabs are applicable to that particular UUNS. Further description of the content of the ten pages is provided below.

There is a summary statement for each UUNS that describes the urgent need and intended use of the equipment solution. Within the summary page there is a link to the original UUNS document. The following information is also summarized for the UUNS:

- Urgent capability needed
- Quantity of equipment needed
- Objective delivery time
- Concept of employment
- Perceived training requirements
- Supportability requirements
- Equipment distribution plan
- Perceived impact to mission accomplishment
- Impact to mission if need not met
- Point of contact
- Estimated cost
- Program of Record recommendation

- Need for doctrinal changes
- Related UUNS requests

The Initial Posting page describes what the requesting unit is asking for in terms of equipment. A datasheet is found on this page that details which of the mission essential tasks (MET) would be partially or fully fulfilled by providing the equipment solution sought for in the UUNS. The initial impression of the technology assessment team is also provided here. Included with the team's initial impression is a record of the decision authority, the decision reached, justification for the decision, and the date the decision was made.

The Planning and Schedule page displays the start date and the planned end review for each phase of the NaIL's analysis. (See items a-h of the Planning and Schedule page above). The Technology Assessment Team's end plan and the overall NaIL end plan dates are also included here. Having projected end dates for each UUNS helps track progress of each UUNS throughout its life cycle at the NaIL.

Within the Required Capabilities page are several datasheets. The more basic, Required Capabilities datasheet lists all of the capabilities the requesting unit identified as being necessary of a solution provided to meet their urgent need. To this, the NaIL analysts will add additional requirements based on their engineering experience. For instance, if the requesting unit only provides their desired operational requirements for the equipment item, then the engineer-analysts at the NaIL will add the implied mechanical or electrical engineering requirements that will insure that the equipment item can meet the desired operational requirements. These requirements will become the core basis of comparison for potential equipment solutions. An additional datasheet is also provided that prioritizes the requirements. Prioritized requirements are valuable in later phases of the NaIL's analysis when technology trade-off decisions have to be made.

The Market Research page provides a basis for comparison of each of the potential technological solutions for the UUNS. Substantial market research information is provided for each equipment item determined to be a potential solution, to include:

- Equipment name
- Developer’s name
- Technical data and description
- Performance specifications
- Estimated cost
- Technology Readiness Level
- Test performance information
- Developer points of contact

All data concerning comparisons of the potential equipment solutions is displayed on the Comparative Analysis page. This page provides data for logical comparisons of the potential equipment solutions, in that most areas of comparison are numerical scores or yes/no answers, based on the required capabilities and their weighted prioritizations made during the earlier phases of the NaIL’s assessment. Here the user will find the prioritized required capabilities, an assessment of how each potential solution meets the required capabilities, and a datasheet that calculates the potential solution’s execution rating. Criteria for determining the execution rating are provided below.

- Item in production?
- Are modifications needed?
- Is item on contract?
- Time to deliver
- Government certified?
- Simplicity
- Initial training
- Training support required?
- Special tools required?

- Spare parts requirements
- System integration
- System interoperability

The final phase of the NaIL analysis wraps-up all of the calculations and decisions from the previous phases and displays them on the Solution Strategy page. This page displays the final results, in many cases numerical results, from the comparative analysis, requirements-capability-suitability determination, execution rating determination, technology readiness level, solution contribution, and solution contribution justification. The output of this page is a logical identification of the equipment solution with the best potential to satisfy the requirements of the UUNS.

Information within the MIS takes several forms. In general, most pages of the MIS present information in the form of tables that allow for useful segregation and comparison of information. This is done primarily because several equipment items are compared during the phases of the NaIL's analysis, thus it is easier to compare them when a "side-by-side" comparison form is provided. Since the input during earlier phases of analysis (i.e., requirements prioritization, market research, comparative analysis, and Technology Readiness Level) is combined for decision during the final portion of the UUNS life cycle (i.e., Solution Strategy) it is imperative that objective numerical descriptors be used wherever possible. Where numerical values are not feasible, short written descriptions are used to convey information. This is especially true on the Summary page and wherever decision justifications are needed.

The NaIL MIS provides excellent information for analysis of each individual UUNS and for evaluation of the UUNS program as a whole. This is largely due to the work of the user-developers of the MIS. Having determined what information is necessary for properly evaluating potential solutions, the MIS user-developers have designed a system that requires all of that information to be input into the MIS. This arrangement insures that all requirements, and technical, funding, and fielding issues

have been addressed and are accounted for in a system that synthesizes data to develop information for an objective analysis of which potential equipment item provides the best solution for the urgent requirement.

Presentation of data and information on the NaIL MIS enhances the managerial decision making process. This is accomplished in at least three different ways. First, information is color-coded where needed. This scheme is especially helpful when assessing program risk and when comparison decisions are needed. Second, because start and end dates are required for each phase of analysis it is easy to produce graphical representations of phase and overall progression. This allows managers to assess the programs according to schedule, and a similar effort could be made to monitor cost and performance progress as well. Third, because much of the information generated in the MIS is in numerical form it removes subjectivity from the decision making process. Because the lives of many USMC personnel will depend on the decisions made to select the right equipment for each UUNS it is important that managers be given objective information from which to draw logical conclusions.

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V. COMPARATIVE ANALYSIS

A. DOES THE NAVAL INNOVATION LABORATORY'S (NAIL) USMC UUNS MIS REPRESENT A SUBSTANTIALLY GREATER CAPABILITY FOR MANAGING NOTIONAL CONCEPTS?

The short answer to this question is, "Yes." The NaIL's UUNS Management Information System (MIS) provides managers with a means of obtaining project information that is faster, more detailed, more current, and more accessible than the system of folders and subfolders currently used to manage Notional Concepts. Project summaries and graphical representations provide for a quick visualization of individual project status, which is essential for managers. Detailed data for individual projects is more thorough in the NaIL's MIS than it is in the Notional Concepts database. Data entered into the NaIL's tracker is immediately propagated throughout the system, which eliminates redundant data entry, saves time, and provides the most current project information available to all users.

1. Management of Data Volume

Data volume is better managed in the NaIL's MIS than it is in the Notional Concepts database. The NaIL's MIS has a single page displaying all of the UUNS project categories. Each project category has a drop down list of every UUNS project that is assigned within that category. Managers only have to click on the hyperlinked project name to arrive at the page dedicated to that UUNS project. All of the information relevant to that project is contained there or a hyperlink to any un-displayed data is provided. Thus, by scrolling over the project category headings on the main page, a user of the NaIL's MIS can easily select the project of interest and then view any of the information associated with it simply by selecting from the available tabbed pages or hyperlinks on the project's page.

Volume management is less accommodating under the current Notional Concept system of folders and subfolders. First, in order to find information on a project, the user

must know which fiscal year the project was started. This is cumbersome if the fiscal year the project started is not known because the system maintains a folder for each year beginning in FY90. This is further complicated if the Notional Concept's control number is not known, as there are can be up to fifty Notional Concepts, listed by control number vice name, within each fiscal year's subfolder. A folder is kept for every project ever started, even those projects that were subsequently cancelled. This requires the user to have a very good idea of where to look for the appropriate project subfolder. Figure 4 is a representation of what a user of the database would have to sort through to find Notional Concept 05-10, the fifth Notional Concept of FY10.

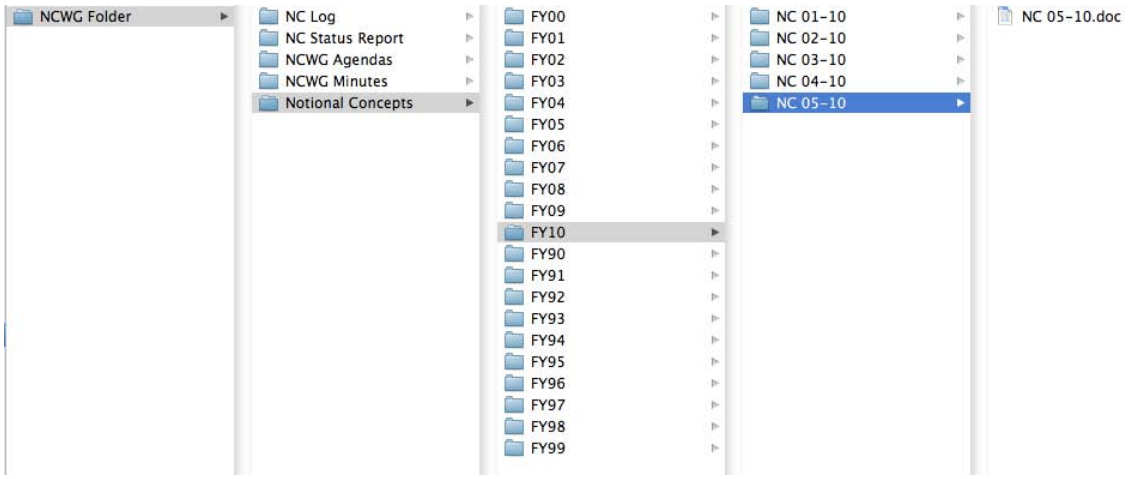

Figure 4. Mock Notional Concept Database

Note that there is no equipment name shown. Users of this database that were not very familiar with the control numbers of specific Notional Concepts or the year in which the Notional Concept was started would have a difficult time finding the information they were seeking. Provided that the user knew the Notional Concept's name, a keyword search could be used to narrow down the folders to investigate. This too could be difficult since every Notional Concept ever introduced resides in the same location of the database. All Notional Concepts are EOD specific, thus any keyword search that contained the word "explosive," for example, would return almost every Notional

Concept ever submitted whether it was cancelled or produced. Repetitive searches to discover the correct folder is time consuming and unproductive.

Thus, the NaIL's MIS does of better job of data volume management because it systematically arranges information so that if it is available, then it is in the same location for every project. The information can be navigated to more easily in the VWE-based MIS rather than trial and error searching throughout a system of folders named by project number.

2. Data Presentation

a. Project Status

The NaIL's MIS presents a pie chart on the summary page of each project that provides both a graphical and numerical representation of the project's completion. From Chapter IV we know that each phase of each project at the NaIL is assigned a starting and end review date at project outset. Thus, a systematic method for evaluation project completion exists for each UUNS but not for each Notional Concept. Such a metric may not be so easy with Notional Concepts since they represent what may be only ideas with no associated technology in existence. Even so, there should be some method for evaluating a project's status based on the project type and the typical steps needed to process each project type.

The Notional Concepts database does not provide a project's status as well as the NaIL's MIS. As discussed in Chapter III, a forty plus page Microsoft Word document is used to track the progress of Notional Concepts. A user of the current Notional Concepts database would have to find the correct Notional Concept within the status report and read anywhere from two to twenty lines of text in order to understand the project's status beyond "in progress" or "pending." There is not a numerical or graphical depiction of the project's progress; there is only a history of what has been done and perhaps what the next step to be taken is. There is no status report for the individual projects within their own subfolders.

b. Project Information

The NaIL's UUNS MIS provides project information better than the Notional Concept database system. Project information is clearly displayed on the main page of each project. All current information associated with the program is plainly located on the project's page, and a selection of page tabs is presented that allows the user to quickly navigate to the necessary page to find the relevant information. Since it is all located on a Web page it is easy to follow hyperlinks or simply use the "back" icon to return to previously viewed information. Most information is provided in a table format that makes it concise and easy to follow. If additional information is needed then a hyperlink can take the user to a page containing all of the documents associated with the program. An additional feature of the NaIL's MIS not found in the Notional Concept tracker is a journal. This journal allows users to post information relevant to the program that is not found elsewhere. Items such as e-mail content and phone conversation information (that is normally not maintained anywhere) can be posted for all users to see. This sort of information can be very valuable to decision makers and positively adds to the organization's corporate knowledge.

The Notional Concept database and associated documents lack the ease of navigation to data, such as linked Web pages and tables, the simplicity of information display (tables and graphs), and any sort of journal to capture the less formal information exchanged by e-mail and telephone. The Notional Concepts database requires users to scan through lengthy documents and self-assimilate the data into decision quality information. This makes the presentation of information less effective even if there is sufficient, relevant information.

3. Access

The NaIL's VWE does a better job than the Notional Concepts database for allowing access to the system. The Web-based NaIL UUNS VWE requires the use of a DoD Common Access Card (CAC), which all service members have as their military identification. With a properly credentialed CAC, a user of the NaIL's VWE can easily access any of the site functions they have permissions for from any location.

This is not so for the Notional Concepts database. Even with full database access permissions a user cannot access the Notional Concepts database except from a Navy Marine Corps Internet (NMCI) terminal. The use of a ".mil" domain, CAC, and NMCI address are not sufficient to access the Notional Concepts database. The implication of this is that all non-Navy members of the JSEOD community not physically located at NAVEODTECHDIV will not be able to access the Notional Concepts database—even if they are designated members of the Notional Concepts Working Group—since they would not have a "navy.mil" (NMCI) e-mail address and use of an NMCI terminal.

Thus, the NaIL VWE allows for greater database access for approved users than the Notional Concepts share drive-based database does. This enhances organizational Knowledge Management (KM) and productivity. The opportunity for remote work is also far better for the VWE than the share drive-based database, as the opportunity to access outside of the NMCI domain is far better.

B. DOES A VWE ALLOW FOR GREATER COLLABORATION IN THE NOTIONAL CONCEPT DEVELOPMENT PROCESS?

Just as the VWE-based MIS provides better information display and greater access to the information in the database than a share drive-based database, the VWE also presents a greater capability for project collaboration than the share drive does. The VWE provides for better information updating, and it also provides for project tasking and response, which a share drive database does not allow for.

1. Information Updating

The benefits of the VWE over the share drive database for information updating are speed, accuracy, and simplicity – which equate to efficiency. This process is easier and more effective with the use of a VWE-based MIS because it presents information in tabular form on Web pages specific to each phase of a process life cycle. This places information exactly where a user would expect to find it for each UUNS. With the share drive database most information updates come in the form of a new document or spreadsheet, or a change to an existing one that a user must find, read in its entirety or

scan for noticeable changes, and interpret. This requires each user to individually perform each of these steps. There is little chance that all users would do this, and even less chance that they would come to the same conclusions about the information they read.

The VWE-based MIS also has the added advantage of pushing the same information to different locations. This insures that information displayed in several areas is exactly the same at each location. Using this approach saves time, as the data entry is made only once. A well-established and administered data entry process helps insure that information is correct throughout the system. Linking the information to several sites prevents improper entries at the various sites and ensures that no site that should be updated is missed.

Reducing the time needed to update users on the new information and improving its accuracy makes the VWE-based MIS more efficient than the share drive. Users will know that the information they are seeing is the most recent and that all users are provided the same correct information.

2. Project Tasking

The VWE-based MIS is well suited for project tasking. As discussed in Chapter IV, the NaIL VWE provides something akin to a Work Breakdown Structure (WBS) to show what project assignments have been made, to whom they were made, and when the assignment is to be completed. Completion is easily reported and the assignment can be color-coded (using a status light) that shows whether the assignment has been completed. This is an excellent managerial tool that allows for quick tracking of project assignments. Electronically tracking the WBS enhances collaboration – especially with dislocated VWE users.

The share drive-based Notional Concepts database provides no means of tasking organizational users with project duties or tracking the progress of those tasks. This forces all project collaboration to be accomplished by phone, e-mail, or in person. Such work is made more difficult for those users not provided with an NMCI terminal, as they have no means of information access other than to receive documents by e-mail. Having no collaborative tasking process slows job completion down because e-mail would be the

only efficient medium to publish job tasking, provide updates, and report completions. Thus, a large volume of e-mail would have to be sent for each item to insure all users are kept informed of the project status. Portions of such a large volume of e-mail are routinely overlooked, misplaced, or perhaps even ignored if it is not perceived as relevant information. Even after making all of the notifications it would not be easy to maintain effective awareness of the status of all of the taskings and their associated completion. A spreadsheet within each Notional Concept project folder would perhaps offer a means of tracking the many details of each project, but this is not currently done. The Notional Concept Status Report is not effective for the level of detail required in process tracking.

3. Communication

When NaIL analysts complete any given task an entry is made into the UUNS MIS, and completion of that task is automatically communicated to all users in the VWE. Face to face meetings and their associated delays are removed by providing a forum for electronic tasking and reporting.

The NaIL VWE provides a journal for each of the UUNS projects. As previously discussed, this is a useful means for collecting information from the VWE users on items of interest that they have found. This is a good collaborative tool that is not found in the Notional Concepts tracker.

Perhaps the most important communication advantage of the VWE is that it removes the linear collaborative process found in e-mails. E-mail collaboration and decision making requires e-mails to be sent from person to person to person to advance a project through its decision chain. With a VWE all persons in the decision chain can simultaneously view the project information from its inception. This greatly reduces the time delay experienced when e-mails and information travel from e-mail inbox to inbox. For example, when the USMC began their UUNS process, information dispersal and decision processing relied heavily on e-mails. Implementation of a VWE at the Marine Corps Combat Development Command reduced the time to process UUNS for approval by the Commandant of the Marine Corps from 180 days to 75 days (R. Simmons, personal communication, October 13, 2009).

C. DOES THE VWE ENHANCE THE DECISION MAKING PROCESS FOR MANAGERS?

The Virtual Work Environment provides managers with better decision quality information faster and more reliably than a share drive database does. The VWE enhances the manager's ability to understand project completion, status of work remaining, and even funding aspects (if desired). Reducing the time needed to analyze the projects provides the manager with more time to focus on problem resolution and future actions.

1. Project Status

Project status is much easier to provide to managers with a VWE. Rather than updating a document or spreadsheet when changes are made, or building a brief for each meeting, the VWE captures relevant status information on the project's summary page, and it is always available to all users. Any additional information that is desired is kept on the tabbed pages that are hyperlinked to the project's summary page. Presenting information from the VWE saves time by removing the need to build briefs for every meeting. Users do not have to e-mail documents, spreadsheets, and presentations around the office or to remote locations to conduct normal business or meetings. Again, the relevant information is always available in a professional manner ready for either analysis or presentation. Thus, a project's status is always available to all users.

Project status for any Notional Concept is only found in the Notional Concept Status Report. This document provides only text, and only the most general status information is provided. Detailed status information does not exist in this document or in the subfolder specifically associated with any given Notional Concept project.

2. Work Remaining

Because the NaIL's MIS is designed to display the eight phases of the analysis they perform, it is very easy for managers to see exactly which phases of the analysis remains to be completed, and if needed, managers can open the phase specific Web page to see what portions of the phase have been completed and what portions remain to be

completed. They can see whom the analysis has been tasked to, when the analysis began, when it is to be completed, and percentage completion. Since the information is largely presented in numerical form managers can make judgments whether the work remaining can be completed according to schedule. These tools help managers to quickly visualize the work remaining on a project and identify areas of concern.

Similar to project status, there is no information provided for the estimated or calculated work remaining for Notional Concepts. Within the Notional Concepts Status Report there may be a short description of the very next step to be taken, but there is no substantial record of what remains to be completed for the project within a particular phase or in total.

D. COSTS

Implementation of a VWE-based MIS represents a source of additional costs that are not incurred with the share drive-based database. These costs are presented in at least three ways. First, there is the cost of obtaining the necessary additional hardware and software. The extent of this cost is dependent upon the technical sophistication of MIS being acquired. Inherent with this is the cost of software upgrades and technical support if available and desired. The second cost is that which occurs to educate the organization's users. If the organization is going to develop the MIS themselves, then there are additional costs to educate the user-developers in the functionality of the software and how to use it to develop a MIS that is right for the organization. This is an ongoing cost – especially in military organizations, which normally have a steady personnel turnover rate. It should be expected that newly arriving personnel would receive adequate training on the software's use in order to maintain a VWE-based MIS if done organically. The third cost is the opportunity cost associated with pulling the users and user-developers of the MIS away from their primary jobs in order to be educated and trained on the MIS software and to perform the tasks of building (if done organically), maintaining, and using the MIS. This cost varies directly with the amount of time that the users and user-developers spend away from their primary job.

Having the organization's users develop and maintain the MIS is a substantial trade-off. On the one hand the organization is avoiding the great costs associated with contracting the development, implementation, and maintenance of the MIS. On the other hand the organization is going to spend money to educate their own personnel in the role of MIS development and maintenance. The organization will also lose those same man-hours that the MIS user-developers are spending away from their primary jobs. This opportunity cost can be exacerbated if the proposed user-developers are not technologically savvy. Simply put, the less skilled the personnel are in software use and development the less time they will spend doing their normal work and the more time they will spend trying to get the MIS developed correctly. Figure 5 shows the interrelationship of cost and end-user development (EUD).

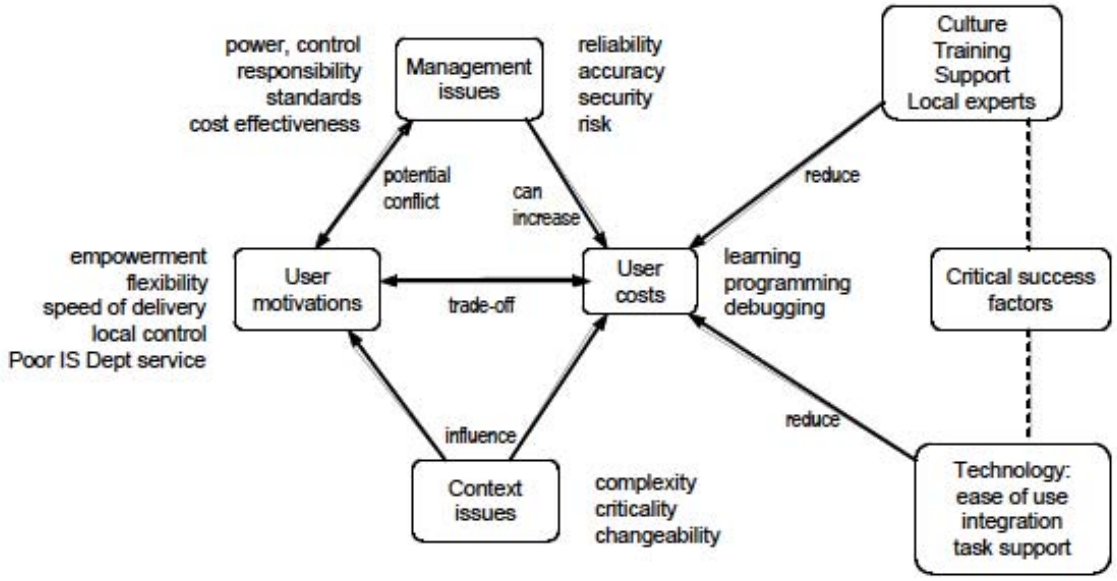

Figure 5. Relationships between Social and Managerial Issues in EUD (From Fischer, Ye, Sutcliffe, & Mehandjiev, 2004)

From Figure 5 it is obvious that there are many other trade-offs and challenges associated with end user-development of software applications other than cost. Those challenges applicable to a potential user-developed MIS are discussed next.

E. IMPLEMENTATION CHALLENGES OF A USER-DEVELOPED MIS

In addition to the start-up, operating, and education costs of implementing a VWE-based MIS there are technical and managerial challenges associated with a user-developed MIS. The primary challenge is producing a quality MIS that ensures proper analysis, coding, testing, documentation, reliability, accuracy, and security while minimizing risk, complexity, and user-developer's time spent away from their primary job.

MIS implementation begins with the education and training of all user-developers and creating a process that insures continuing education. Having achieved the proper personnel education, management must then establish controls that will insure that development of and changes to the MIS are properly documented and repeatable. Documentation must be kept to record how the functions of the MIS were developed. If not, follow-on user-developers will devote a great deal of time trying to discover how the various functions of the MIS were coded. This is necessary before the MIS is developed and is needed for the ongoing operation of the MIS as new projects start and personnel turnover occurs. Documentation problems associated with end-user developed software have been acknowledged for years. In 1994, an article entitled "Quality Issues for End-User Developed Software" was published in the *Journal of Systems Management*. The author states (Cale, 1994):

> One of the overriding concerns caused by the trend towards end-user computing has been the potential decrease in quality and control as individuals with little or no formal information systems training have increasingly taken responsibility for developing and implementing systems of their own making. Not the least of these control risks is inadequate testing and documentation of the system once developed.

There must also be controls that insure that the functions of the MIS are properly coded. This is not the normal work of process personnel, so there must be a system to verify and validate the coding that the MIS is built upon. Management and user-developers will be challenged to properly identify what data needs to be used in the MIS, how the data is to be used in the MIS, and how to properly code functions to reliably use the data.

Testing of the MIS coding for functionality and accuracy is necessary for a reliable MIS. A properly developed MIS can and should be the primary source of information for the organization it serves. Testing of the underlying code must be done systematically during MIS development to verify that “final products” (MIS functions) operate correctly before they are validated for use.

Management must also insure the continued accuracy of data input to the MIS. The MIS can push data to various locations within the system for use in other calculations and functions, which makes the spread of erroneous information easy. The MIS generates information in several areas based off the input of data into the system. This information is expected to be correct for decision-making purposes. Thus, controls must exist that safeguard against erroneous data input and propagation in the MIS in order to produce quality information.

System security can be divided into two aspects. First, there are permissions that must be granted as to who may develop the MIS functions and perform data entry. Management sets these permissions based on their personnel’s responsibilities and MIS development skills. This aspect of security considers those who have legitimate need for usage of the MIS. Security against outside access by those who have no need to access the MIS is a responsibility of the organizations IT Department. While security against outside unauthorized access in not a function of the process managers, they should at least understand what the IT Department provides for them and how it affects their MIS.

The challenges listed thus far—system cost, education, analysis, coding, documentation, testing, accuracy, reliability, and security—are effectively trade-offs that managers have to balance. These trade-offs are made based on the risk managers are willing to accept regarding the surety of their MIS. The greater the organization’s dependence on the MIS the more managers will be willing to divert user-developers to MIS management. Again, this comes as an opportunity cost. Time spent on MIS management is time spent away from primary duties.

Similarly, the inherent complexity of the MIS or its software foundation will also become a factor in time devoted to MIS management. No MIS will be as simple to

develop and maintain as a share drive-based database. Therefore, it should be expected that implementation of a MIS will divert user-developers away from their primary duties far more than the routine usage of a share drive-based database would – especially during the developmental stages.

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VI. IMPLEMENTATION STRATEGY

Implementation of a Virtual Work Environment-based Management Information System in place of a share drive-based database makes sense for the management of Joint Service EOD Notional Concepts, based on the comparative analysis in Chapter V of this report. The VWE-based MIS is a more effective and efficient means of data storage, information generation and display, decision support mechanisms, information access, and collaboration than the share drive-based database. The following specific recommendations for the JSEOD are made regarding the implementation of a VWE—although these recommendations would enhance the management of any program.

A. Leaders Advocate the Virtual Work Environment

Leadership advocacy of the change to a VWE from a system that has been in use for well over a decade is crucial. Implementing a change in the way the organization's personnel complete their work, and probably have for the majority of their career, may require as much behavioral management as it does technical management. Gordian Transformation Partners provides the following list of reasons why some people resist change (Baker, 2004):

- Old and routine is known and comfortable
- Not knowing the reason for change
- Not knowing what is expected of them
- Not knowing how to change
- Perception of imbalance between giving and receiving
- Taking change personally!
- Fear of getting hurt by the change
- Need time to integrate and get comfortable with the change

Resistance to change is indeed an obstacle, but not one that cannot be overcome. Changing an organization's cultural mindset (and way of doing business) requires patience and even personal change. Personnel must see the leader get onboard with a new program. Kerry Baker, writing for Gordian Transformation Partners, advocates welcoming the resistance that personnel present because it is a signal that the change is taking place. He provides a few tips for leading effective change (Baker, 2004):

- There are three triggers for people to choose change: pain, payoff, and perception.
- Change creates insecurity and confusion.
- Change is giving up one thing for another.
- Giving up something involves loss.
- Change is emotionally charged.
- People cannot fully move on to the new until they process the feelings that accompany the loss.
- Humans resist most changes to some degree. The more negatively the change is perceived, the more it is resisted.
- Resistance allows time to sort out new information.
- Often change is resisted out of fear of the future, not love of the past.
- To manage change one has to understand the role and importance of the emotions.

Understanding how the personnel involved in the Notional Concepts Working Group will react to the large change that implementing a VWE will create is a key to responding to the resistance they may offer. Believing that a military organization will not present resistance to a directed change is stretch, at best. Despite being military personnel accustomed to following orders, they may still prove to be resistant to such a change. In an article for *Human Resources Development Quarterly*, David Szabla relays

his findings regarding how an organization's personnel responded when subjected to a research effort concerning the effectiveness of three leadership approaches toward change—rational-empirical, normative-reeducative, and power-coercive—with regard to resistance to organizational change. The three approaches can be understood as follows:

- Rational-Empirical—Reason and logic are applied to convey the importance of the intended change.
- Normative-Reeducative—Personnel who will be affected by the change are educated about the new item and participate in its design, development, and deployment.
- Power-Coercive—Persons of authority decree the change and use their positions of power to implement it.

Personnel cognitive, emotional, and intentional responses to the research study of the organization's change implementation process were scored and analyzed. Szabla's findings indicate "change respondents who perceive a power-coercive change strategy will have less positive cognitive, emotional, and intentional scores compared to those who perceive a rational-empirical or normative-reeducative change strategy" (Szabla, 2007). Simply put, this means that personnel tend to accept organizational change better when the need for change is logically demonstrated and implemented in a participative fashion rather than by coercion. This may best be accomplished for the Notional Concepts Working Group by education and iterative implementation as described below.

B. Educate and Build

As discussed, participation by all NCWG members will be a key to implementing a VWE-based MIS for the NCWG. To begin this process, the new users of a NCWG VWE must understand how to use the necessary software to populate the MIS with data. If the NCWG decides to build the MIS themselves then a substantially greater effort will be needed to educate MIS user-developers. Many applications have self-contained tutorials that can be used for basic education. It would also be worth the investment to procure additional technical support from the manufacturers that would provide more

advanced education for user design skills if the MIS is developed organically. Forums and collaboration groups exist for many applications to develop user-to-user skill sharing and assistance. Finally, additional education opportunities may include site visits with organizations that have already implemented successful VWE-based MIS's.

The purpose of this education is not simply to demonstrate the need for the use of a VWE, but also to build the skills the NCWG will need for maintaining their own MIS. User development of the NaIL's VWE-based MIS was a key to its successful implementation. Soliciting input for the development of an NCWG MIS from the NCWG members would provide them a voice in the organizational change, allow them to participate in the iterative building of the VWE to the point that it works best for their day-to-day use, and it will also help them better understand the requirements of the Notional Concepts they develop.

An iterative building process is essential to creating a successful VWE for several reasons. First, the design and development of the VWE-based MIS does not belong to the IT Department. Those duties belong to the MIS's users who are transitioning away from e-mail and a share drive-database and who are not accustomed to using a VWE or a MIS. Second, building a VWE is not just a matter of transferring the contents of the share drive to the VWE library. That would be a waste of time and money. The VWE-based MIS has far more capability to generate decision-quality information and to facilitate collaboration, and it should be used accordingly. Discovering how to make use of its full capability will take time. Third, it is not possible, nor should it be attempted, to have a team design a one-time VWE/MIS solution on paper to implement once the requisite hardware and software are established. The process of designing the VWE-based MIS is one predicated on trial and error. It will take months, perhaps even a few years, to develop and implement a VWE that is finely tuned and meets all of the needs of the NCWG. That is not to say that the NCWG will always be trying to establish the VWE-based MIS, but rather that they will be implementing small changes intermittently as they perceive the need and their MIS utilization skills grow.

C. Develop a Solid Management Information System

The power of the VWE is that it can be far more than a collaboration tool or a means for greater user access. It provides the means to more accurately and effectively manage multiple programs and generate decision-quality information. Items of specific interest to the NCWG may include:

- Electronic Notional Concept submission through a Web enabled form
- Collective groups for Notional Concepts according to project type
- Collective groups for Notional Concepts according to service sponsor
- Segregation of inactive and cancelled Notional Concepts
- Summary page for all Notional Concepts of a given project type
    - Color coded program status for each Notional Concept
    - Capability to link to the individual Notional Concept pages
- Individual page for each Notional Concept with the following sub-pages
    - Summary Page—includes completion percentage and output from other sub-pages, such as:
    - Requirements Page—based on user stated, implied, and technical requirements and prioritization
    - Planning and Scheduling Page—for each phase of NCWG analysis and entire life cycle of the Notional Concept
    - Market Research Page—potential solutions, associated specifications, and other product data such as cost information
    - Technology Readiness Page—identified TRL and assessed technological risk of each potential solution
    - Competitive Analysis Page—results of design and prototype testing, technology readiness (risk), integration/interoperability issues, and requirements fulfillment

    - Decision Information Page—objectively evaluate all information on each potential solution—competitive analysis and cost considerations
    - Journal Page—collect all information that can be captured through mediums outside of the VWE
- Others as necessary to track the progress of Notional Concepts from submission to Joint Service Project Type decision
- Funding Tracker
- Video chat capability

This list closely reflects what is found in the NaIL's VWE-based MIS, and for good reason. The engineers at the Naval Innovation Laboratory have invested a lot of time into building a system that generates very thoughtful analysis of urgent capability requirements and their potential solutions. The process for evaluating UUNS is similar to the process used to evaluate Notional Concepts. The UUNS process differs mainly in the abbreviated time to fielding requirement and lower technological risk, whereas Notional Concepts are items that are in the very early stages of the development and are expected to have a long legacy of military use if fielded through a Program of Record. Thus, the process used by the NaIL for producing objective, number-based analysis is well worth considering by the NCWG. Investigation of the the NaIL's processes would be a good first step in the NCWG's iterative development process. The NCWG must determine what processes are relevant to Notional Concepts, implement those processes, and then design a more tailored program. The NaIL processes are a solid foundation should they can be incorporated in the Notional Concept environment.

D. Design for Effectiveness

The purpose of the Notional Concept program is to discover technologies that solve mission capability gaps. To that end, Notional Concepts should be viewed as a means of filtering ineffective solutions while preparing promising solutions for program acquisition. That is effective use of 6.2 and 6.3 program funds.

A VWE-based MIS used by the NCWG must be capable of delivering an accurate, easily discernable program status for managers. Managers do not need to waste time searching through documents to gain an understanding of a program's status. They need to be able to focus their time and energies on leading programs.

The MIS must be capable of improving the analysis capability and capacity of the organization's members. NCWG personnel should be able to develop an effective, repeatable process for analyzing potential Notional Concept solutions through each phase of its life cycle.

The MIS should aid the NCWG in identifying promising technologies – the ones that should transition to Programs of Record. A project should have a Technology Readiness Level (TRL) of six to seven before it can be transitioned into an effective, system-specific 6.3 program. "A good Management Information System should monitor the march to maturity. The 6.3 program should be preparing the Notional Concept for acceptance by the future Program Manager as a 6.4 program" (J. Yakovac, personal communication, October 16, 2009).

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VII. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

The utility of a share drive-based database for program management would be greatly exceeded by the implementation of a Virtual Work Environment-based Management Information System. The VWE allows for far greater access and collaboration while the MIS portion of the system offers unparalleled data analysis, information display, and decision support. A user-developed VWE-based MIS, while inherently risky, can be cost effective since it avoids the high costs of contracting software development. There are some outstanding trade-offs and standardization issues that have to be considered when relying upon user-developed software. Avoiding the high costs of software engineers means that the organization's non-software engineers are now tasked with software development duties that they are unlikely to be familiar with. This shortfall in programming expertise requires process personnel to be trained to develop the necessary software coding required to develop a MIS. Time spent pursuing this training and then making use of it to develop the MIS results in process personnel spending less time performing their normal duties. There are also substantial issues concerning quality and reliability of user-developed software. Managerial controls and developer education are the best answer to these issues.

The VWE-based MIS also provides much better accessibility for remote users. This accessibility increases collaboration and process efficiency since barriers to information access are removed.

A well developed and maintained MIS can increase organizational efficiency and effectiveness, thus providing a valuable return on investment. Education is critical to reducing the risks associated with reliance a new MIS. Educating organizational personnel has also been found to be the most productive means of reducing resistance to implementation of a new system. This same education helps insure that personnel can productively use the VWE-based MIS, which is especially important in military organizations where personnel turnover occurs frequently.

Implementation of a VWE-based MIS can be an effective asset for many organizations seeking to improve their performance, streamline processes, and save time and money. This equates to better efficiency and effectiveness for individuals and the organization as a whole. Incorporation of a VWE-based MIS would provide program leaders with a valuable decision support system that is flexible and able to be expanded easily. The VWE-based MIS is a versatile system that would potentially enhance the operation of the process-oriented organization.

B. RECOMMENDATIONS

The Notional Concepts Working Group should consider the implementation of a VWE-based MIS for the management of the Notional Concepts process. The VWE-based MIS is a far more powerful tool for managing the Notional Concepts development process than the current share drive-based database.

A secondary recommendation is that the necessary resources for proper development and implementation of a VWE-based MIS be allocated for NCWG personnel. This includes funding for general training for all personnel in MIS use, advanced training for the personnel responsible for developing the MIS (if done organically), technical support for the VWE and MIS applications, and travel for personnel to visit sites where successful management information systems are in use. General and advanced training must also be made available to personnel joining the NCWG after the MIS has been implemented.

Inherent in the recommendation to pursue a VWE-based MIS is the requirement to allow personnel the time needed to populate the MIS and become proficient in its use. Given the need for an iteratively developed MIS, time away from primary duties will be even more important. This of course should taper off as personnel become more familiar with MIS development.

The NaIL's VWE-based MIS is an excellent model for the NCWG to emulate. While the NaIL is required to processes UUNS at a much faster pace than the NCWG processes Notional Concepts, there is a good deal of similarity between the programs and their associated processes.

The NCWG should develop a system by which to monitor the progress of Notional Concepts as they proceed through their life cycle. Each category of joint service project types should have a fairly standard means by which the associated Notional Concepts are investigated, developed, tested, and analyzed such that a repeatable and measureable process can be used to monitor their progress. The information pages described in Chapter V are representative of this type of structure. Such a process will allow managers to better visualize and understand how each Notional Concept under development is progressing. Process standardization and mapping will aid the NCWG in reducing the time required to develop Notional Concepts. This recommendation is independent of any decision to implement a new MIS.

C. SUMMARY

In summary, the VWE-based MIS is an effective way for the NCWG to provide better decision-quality information and access to its members. It is more efficient, effective, and flexible than a share drive. If implemented properly the MIS will likely provide a much better return on investment than a share drive-based database provided the quality control risks are properly addressed. The NCWG should find the VWE-based MIS a far better process management platform for the development of future Notional Concepts.

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